found on page 12, lines 28-29. Support for new Claim 13 is found on page 9, lines 9-10. Support for new Claim 14 is found on page 13, lines 18-31. Support for new independent Claim 15 is found in the original claims. Support for new Claims 16-21 is found in the original Claims. No new matter is believed to have been added by this amendment.

## REQUEST FOR RECONSIDERATION

Applicants thank Examiner Nguyen and the Examiner's Supervisor Mr. J. Jackson for the helpful and courteous discussion of April 4, 2002. Issues regarding the novelty and unobviousness of the presently claimed invention with regard to the architecture of the EL phosphor multilayer thin film were discussed. Details of the discussion follow below.

Applicants thank the Examiner for the helpful suggestion to amend the claims to state that the phosphor thin film is directly adjacent to the dielectric thin film. The Examiner's suggestion has been incorporated into present Claim 1.

The present invention is directed to an electroluminescent (EL) phosphor multilayer thin film that contains a phosphor layer. The EL phosphor multilayer thin film of the present invention has an architecture in which the phosphor layer is directly adjacent to a dielectric layer containing an alkaline earth oxide.

The high temperatures needed to process thin films containing ternary compounds that have high crystalline temperatures can result in the diffusion of Ba and S from the phosphor layer into the dielectric ($BaTiO_3$) layer. Alkaline earth oxide thin film layers are able to capture mobile ions such as Pb that migrate from the substrate layer. The presently claimed architecture allows the egress of elements from the phosphor layer by diffusion while preventing the entry of elements migrating from the substrate layer into the phosphor layer.

Claims 1, 3-8 were rejected under 35 U.S.C. §102(b) in view of patents to Dye et al (U.S. Patent 5,834,053) and Sun et al (U.S. Patent No. 5,309,070).

Both the Sun and Dye patents are directed to devices containing several thin film layers. The architecture of these devices is shown in Figures 1 and 5 in the Sun patent and Figures 1 and 2 of the Dye patent (these figures are reproduced on the following pages for convenience). The Figures of both patents describe architectures in which the phosphor layer is sandwiched between two layers of ZnS which are identified as especially important (Dye, col. 4, line 1; Sun, col. 2, lines 18-23 and col. 3, lines 29-32). The phosphor layers of the prior art references are not directly adjacent to a dielectric layer that contains an alkaline earth oxide.

Applicants submit that Dye and Sun do not anticipate the presently claimed invention since the patents do not disclose a structure containing adjacent phosphor and alkaline earth oxide layers.

Applicants respectfully request the withdrawal of the rejection under 35 U.S.C. §102(b) in view of the Dye and Sun patents.

Figures of Dye and Sun

Sun - Figure 1

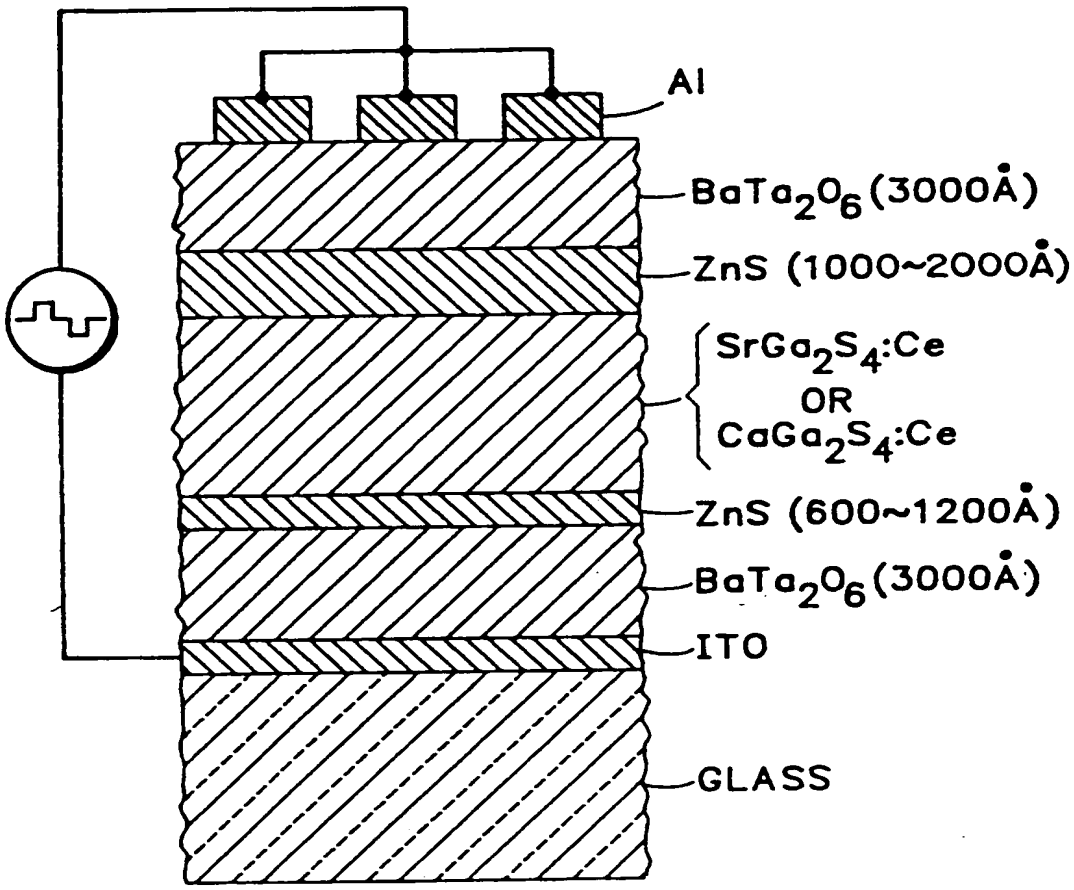



*FIG. 1*

Sun - Figure 5

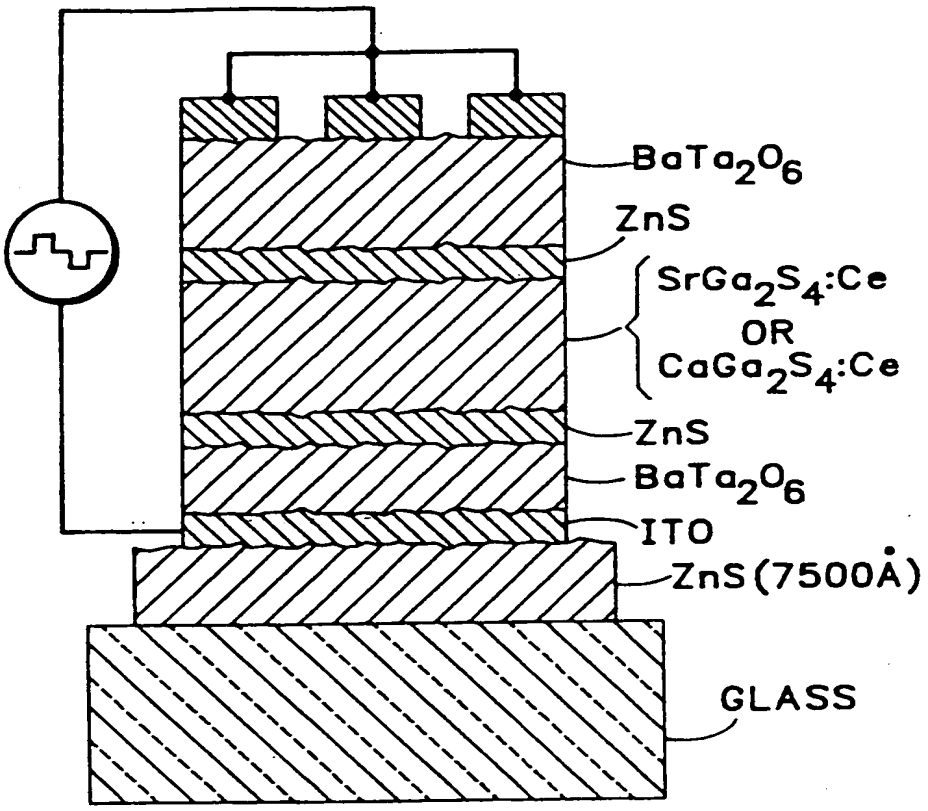



*FIG. 5*

Dye - Figure 1

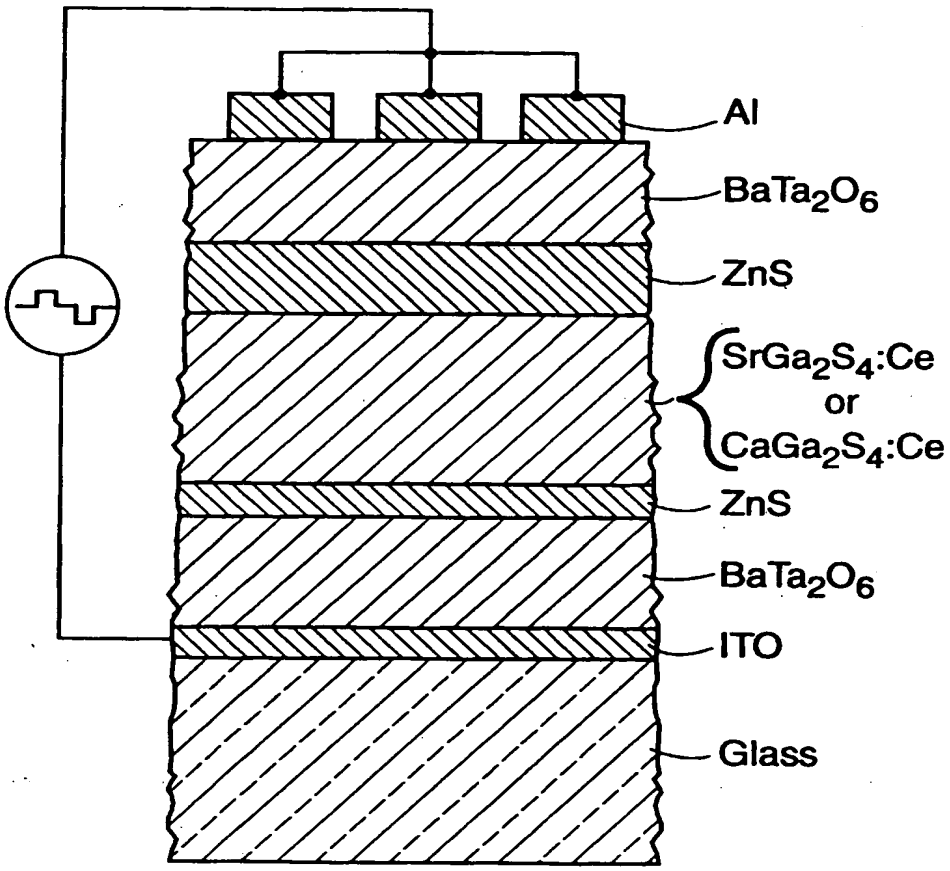



***Fig. 1***

Dye - Figure 2

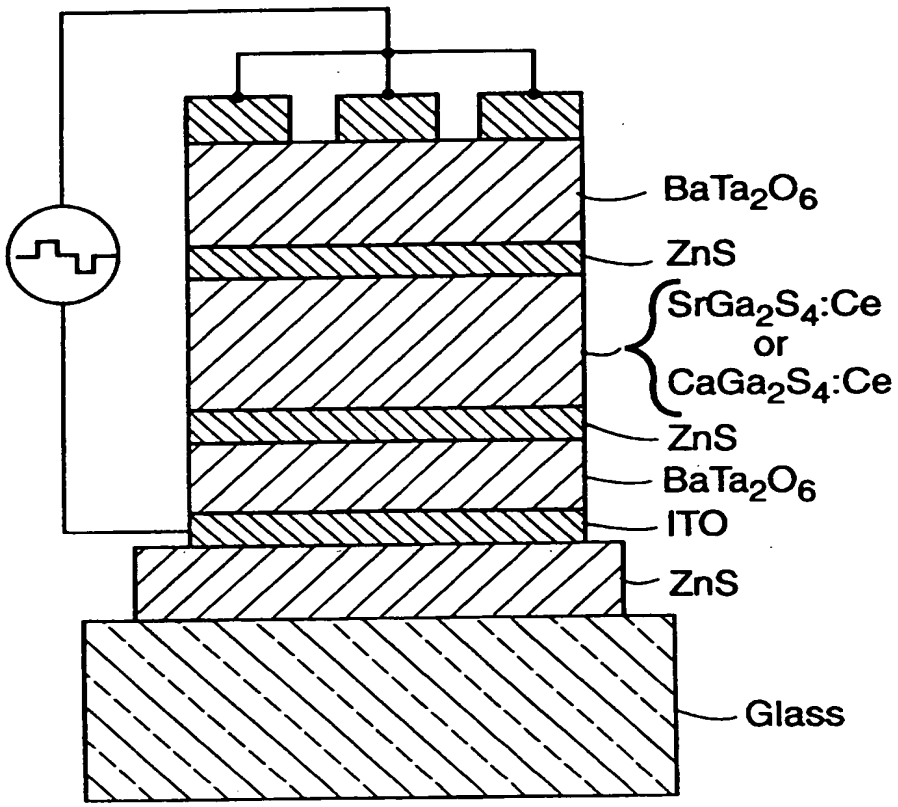



***Fig. 2***

Applicants submit that the inclusion of additional layers into the structure of a multilayer thin film device, such as the EL phosphor of the present invention, is not preferred in the absence of a quantifiable benefit. Since each layer requires a separate processing step, additional layers increase the cost and complexity of manufacturing. If it were possible to prepare the prior art devices without the ZnS film, one would be expected to do so in order to make them easier to prepare. The fact that the Dye and Sun patents (i) describe architectures which include ZnS layers, (ii) emphasize the importance of these layers, and (iii) do not base their respective examples on simpler structures, indicates that a structure with directly adjacent layers of phosphor and alkaline earth oxide thin films without a ZnS buffer layer is not obvious. Therefore the absence of a comparable ZnS layer in the presently claimed invention is not obvious since (i) the ZnS is described as important in both of the prior art references cited, (ii) the direct contact between the alkaline earth oxide-containing thin film and the phosphor thin film provides a benefit unrecognized in the prior art, namely the diffusion of elements from the phosphor layer into the thin film layer, and (iii) the omission of this part of the multilayer device architecture in the present invention does not result in a decrease in the functionality or performance of the presently claimed thin film.

Applicants submit that the presently claimed invention is not obvious in view of the Dye and/or Sun patents.

Claim 2 was rejected under 35 U.S.C. §103(a) as unpatentable over the combination of Dye or Sun with a publication to Miura et al (Jpn. J. Appl. Phys. Vol. 38 (1999) pp. L1291-L1292).

The device described in Miura contains a phosphor film sandwiched between two ZnS films. The Dye, Sun and Miura references together or individually do not describe or suggest an EL phosphor multilayer thin film wherein the phosphor layer is directly adjacent to a

dielectric layer containing an alkaline earth oxide. The prior art cited cannot therefore render the presently claimed invention obvious. Applicants respectfully request the withdrawal of the rejection under 35 U.S.C. §103(a) as obvious over the combination of Dye or Sun with Miura.

Claims 1-8 were rejected under 35 U.S.C. §103(a) as obvious over Kitai et al (U.S. Patent. No. 5,897,812) in view of Miura.

The Office has stated that the Miura reference discloses that a barium thioaluminate can be used as a phosphor layer in a multilayer architecture. The Office combined the Miura patent with Kitai to yield a combination wherein the barium thioaluminate is used as a phosphor in a device that has an architecture wherein the phosphor layer is in contact with the $BaTiO_3$ layer.

The presently claimed EL phosphor multilayer thin film exhibits high luminance even at low voltages. The luminance characteristics of the present invention are shown in Figure 3 of the specification (Figure 3 of the present Drawings is reproduced on the following page for convenience).[1] In contrast, the device of Kitai shows poor luminance. For example, Figure 2 of Kitai (reproduced on the following pages for convenience) shows that at 250 volts the luminance is less than 10 $cd/m^2$ whereas in the presently claimed invention the luminance at 250 volts is approximately **650 $cd/m^2$**. The Kitai architecture therefore provides devices that do not produce large amounts of light at a given voltage. In comparing the architecture of Miura with the architecture of Kitai, one would not have a reasonable or rational basis for believing that the architecture of the Kitai reference would yield an EL phosphor multilayer thin film exhibiting the luminance properties of the presently claimed invention.

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[1]Luminescence is measured in units of $cd/m^2$ or footLambert (fL). One footLambert is approximately 3.5 $cd/m^2$.

Figure 3 of present application

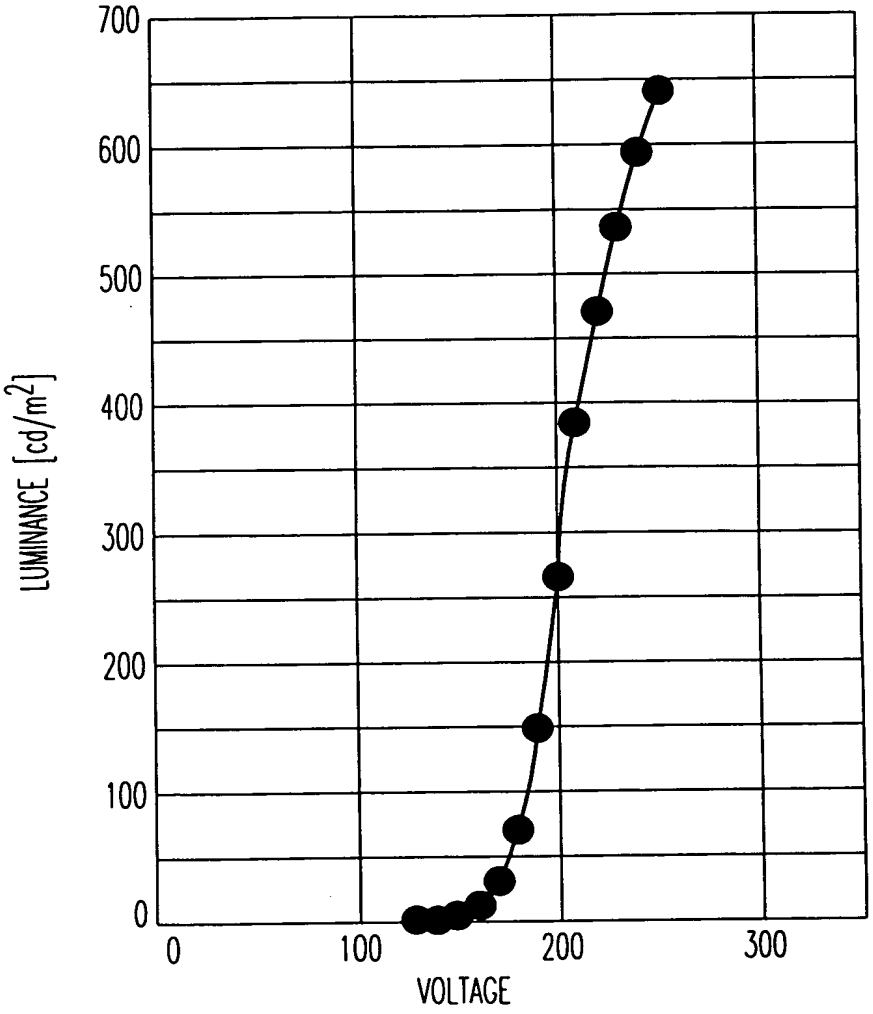



*FIG. 3*

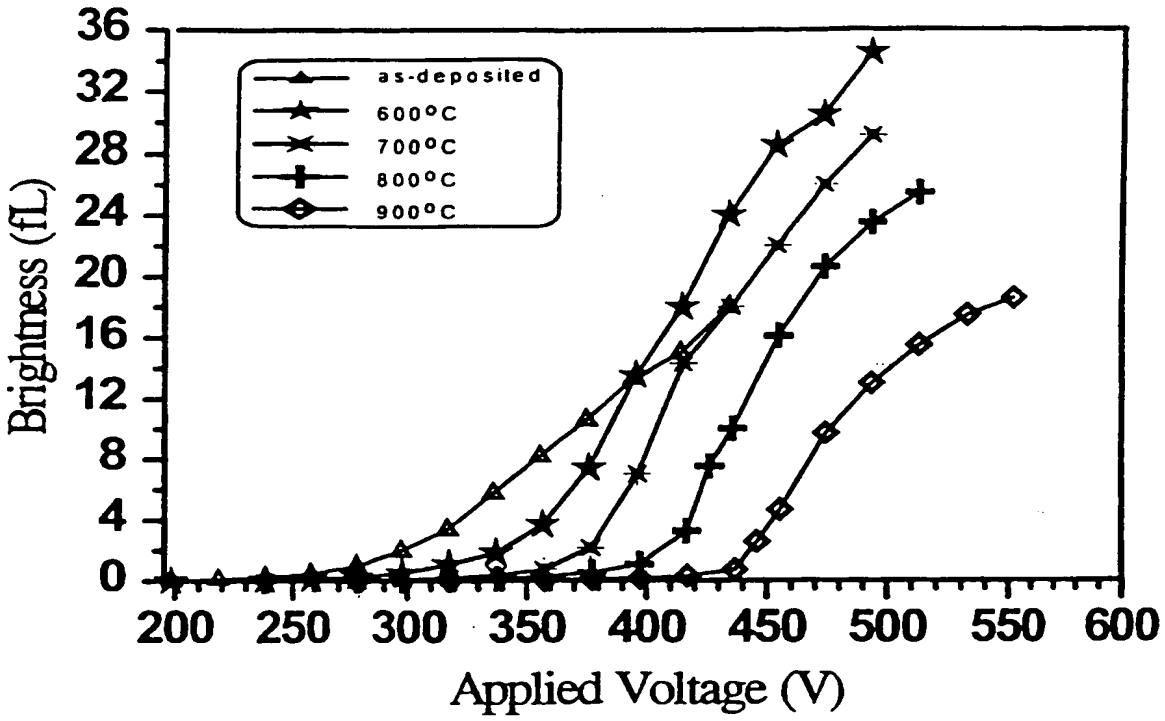

36
32
28
24
20
16
12
8
4
0
Brightness (fL)
as-deposited
600°C
700°C
800°C
900°C
200
250
300
350
400
450
500
550
600
Applied Voltage (V)

**Figure 2**

As a whole, the prior art cited suggests that the architecture of Kitai will suffer drawbacks, such as oxidation, in comparison to the ZnS sandwiched phosphor layer of Miura. Applicants submit that one of ordinary skill in the art, working from the disclosure of the Kitai patent and the Miura publication, would expect that a barium thioaluminate employed in an architecture similar to that of Kitai would yield an electroluminescent device of inferior properties. In contrast, Applicants have shown that an architecture wherein the phosphor layer is in direct contact with the alkaline earth oxide dielectric layer yields an EL device exhibiting high luminance.

Applicants submit that the combination of Miura and Kitai does not suggest that the incorporation of a phosphor layer and dielectric film layer in direct contact can provide electroluminescent devices that have high luminance. Thus, the presently claimed invention is not obvious in view of the prior art cited.

New independent Claim 15 and dependent Claims 16-21 have been added. Claim 15 limits the phosphor thin film of original Claim 1 to alkaline earth thioaluminate and the dielectric thin film to a perovskite oxide. Alkaline earth thioaluminates are not disclosed or suggested in the Dye and Sun patents. Independent Claim 15 is therefore not anticipated by the prior art references.

Since new independent Claim 15 contains the limitations of previous claims 1, 2 and 4, the rejection of original Claim 2 (new dependent claim 16) in view of Sun/Dye and Miura as obvious is rendered moot in view of the requirement that the dielectric thin film of Claim 15 must contain a perovskite oxide.

As was discussed above, a device containing the presently claimed barium thioaluminate-containing thin film exhibits significantly higher luminance than the prior art

device of Kitai. Thus the thin film of new independent Claim 15 is unobvious over the combination of Kitai and Miura.

Responsive to the Examiner's request, a letter requesting approval of drawing changes is submitted concurrently herewith. The Letter adds the subtitle "Prior Art" to Figure 2. Further with regard to the Drawings, layer 7 in Figure 1 is now identified in the specification as an intermediate layer. Support for the amendment to the specification is found in the specification on page 13, lines 32-33 and in Fig. 1. Therefore layer 7 may be an intermediate layer appearing between any of the constituting layers as indicated in Figure 1.

An Information Disclosure Statement was filed with the Office on February 12, 2002. The submission to the Office included a Form PTO-1449 containing two references. A signed and initialed copy of the Form PTO-1449 was not returned with the last Communication from the Office. Applicants respectfully request the Office return a signed and initialed copy of the Form PTO-1449 with the next communication from the office. A copy of the Form PTO-1449 is attached herewith for the Examiner's convenience.

Applicants therefore request the reconsideration and withdrawal of the outstanding rejection, and the passage of all now pending claims to Issue.

Respectfully submitted,

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OF AMENDMENT AND REQUEST FOR RECONSIDERATION

IN THE SPECIFICATION

Please replace the paragraph on page 13, lines 32-36 with the following paragraph.

--Between adjacent constituting layers, there may be provided intermediate layers such as a close-contact improving layer, a stress relaxing layer and a reaction control layer. Such a layer is shown as 7 in Fig. 1.The flatness of the thick film may be improved by polishing the surface thereof or using a flattening layer.--

IN THE CLAIMS

Please amend the claims as follows.

1. (Amended) An EL phosphor multilayer thin film, wherein[:]

a phosphor thin film and a dielectric thin film are [stacked one upon] directly adjacent to another,

said phosphor thin film [comprising] comprises a matrix material containing as a main component at least one compound selected from an alkaline earth thioaluminate, an alkaline earth thiogallate and an alkaline earth thioindate, and [an] a rare earth element as a luminescent center, and

said dielectric thin film [comprising] comprises an alkaline earth oxide.

14-21. (New).